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Wool — Determination of short-term irregularity of linear density of slivers, rovings and yarns, by means of an electronic evenness tester

Laine — Détermination de l'irrégularité de masse linéique à court terme des rubans, mèches et fils, à l'aide d'un régularimètre électronique

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2649 was drawn up by Technical Committee ISO/TC 38, and circulated to the Member Bodies in June 1972.

It has been approved by the Member Bodies of the following countries :

Belgium	India	Spain
Brazil	Iran	Sweden
Bulgaria	Ireland	Switzerland
Canada	Israel	Thailand
Czechoslovakia	Italy	Turkey
Denmark	Japan	United Kingdom
Egypt, Arab Rep. of	New Zealand	U.S.A.
Finland	Poland	U.S.S.R.
Germany	Romania	
Hungary	South Africa, Rep. of	

This International Standard has also been approved by the International Bureau for the Standardization of man-made Fibres (BISFA).

The Member Body of the following country expressed disapproval of the document on technical grounds :

France

This International Standard is based on the IWTO test method 18, drawn up by the International Wool Secretariat (IWS).

Printed in Switzerland

Wool — Determination of short-term irregularity of linear density of slivers, rovings and yarns, by means of an electronic evenness tester

0 INTRODUCTION

The determination of short-term cross-sectional irregularity is of great importance, both for the evaluation of sliver or yarn quality and for an active control of preparation for spinning.

In order to obtain an irregularity value as near as possible to a well-defined absolute value, it is necessary to standardize the test method applied for the determination, and to observe certain precautions in the control and operation of the evenness tester.

The object of this International Standard is to give the necessary guidance in this respect.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method applicable for the determination of short-term irregularity of linear density of yarns, rovings and slivers of pure wool, from 5 tex up to 40 kilotex.

The method is not directly applicable to fibre blends.

2 GENERAL

The aim of a measurement of short-term cross-sectional irregularity obtained by an electronic evenness tester is to evaluate the total cross-sectional irregularity for the yarn or sliver delivered by one machine head.

Appreciable differences in mean count may, in fact, exist between various heads of the same machine (i.e. in linear density determined on lengths between about 20 and 100 m). These differences between heads will not be included in the total cross-sectional irregularity considered here, as the variations from the mean are determined for each head in relation to the mean linear density of the material delivered by the head in question.

Thus an evaluation is made of the dispersion between the masses of short lengths L_b of yarn or sliver within a very long length L_p corresponding to the total length of a production unit delivered by one machine head. (This production unit may be a ball of top, a can of preparation sliver or roving, a package of yarn, etc.)

The parameter used to characterize this dispersion will be the coefficient of variation between the masses of the lengths L_b within the length L_p (b = between, p = package).

In principle, to obtain a value as near as possible to the total cross-sectional irregularity L_b should tend towards 0 and L_p towards infinity.

In practice, as the components of the high frequency spectrum make only a small contribution to the total irregularity, there is not much point in reducing L_b below about 10 mm; moreover, considerations of maximum sensitivity and admissible drift for electronic evenness testers prevent a value much lower than this limit being used.

Length L_b for electronic evenness testers is generally 10 ± 3 mm for yarns and rovings, and may reach 20 mm for slivers.

Regarding L_p, experience shows that irregularity within a length of 250 m (yarn or sliver) is practically always comparable with total irregularity.

The coefficient of variation CV (L_b, 250 ml), with $L_b = 10 \pm 3$ mm will thus be considered as a reference measurement to which the result obtained with the evenness tester must correspond as closely as possible.

In its normal method of operation (Normal Test) an electronic evenness tester fitted with an "integrator" enables the evaluation of the coefficient of variation CV, or the coefficient of deviation CD designated as U[1], between the masses of short lengths L_b within a long length L_w[2], these lengths being defined as follows :

1) Length L_b is practically equal to length L_c (measured in the yarn direction) of the electrodes of the measuring condenser. On any one machine it may vary for different forms of material according to the condenser chosen. The lengths L_c of the Zellweger-Uster evenness tester for yarns, rovings and slivers, are given in clause 3.

1) The coefficient of deviation CD or mean deviation divided by the mean is designated "U" on the dial of the Zellweger-Uster integrator.

2) L_w : w = within.

2) Length L_w is determined by the following three factors, the third being of minor importance :

a) the electrical characteristics of the integrator (more precisely : the time constants T_1 and T_2 expressed in seconds);

b) the running speed V of the yarn or sliver in the machine expressed in metres per second;

c) the slope $(-n)$ in logarithmic co-ordinates of the length variance curve $B(L)$ of the specimen yarn or sliver. (n is a function of the relative size of the long-term irregularities. The $B(L)$ curve is defined as the CV^2 of mass of length L as a function of this length L.)

In order to obtain a value of $CV\ (L_b, L_w)$ as defined above, L_w must be made as large as possible by selecting the highest admissible running speed; it will also be necessary to measure a sufficiently long length L_s[1] of a production unit, and always greater than L_w.

In some cases (rovings and slivers) the running speed will be limited by the properties of the material, and in other cases (yarns) by considerations of frequency response of the evenness tester or capacitance limits of auxiliary instruments (for example the imperfection indicator). The speeds and times of measurement ($T_s = L_s/V$) laid down in the method described are the best compromise.

In this way, in the majority of cases corresponding to normal yarns and slivers, a $CV\ (L_b, L_w)$ value will be obtained which is a sufficiently accurate estimation of the reference measurement $CV\ (L_b, 250\ m)$ to within 5 % (relative).

The $CV\ (L_b, L_w)$ measurement obtained by the method described may thus be generally used directly, without correction, as the origin of a curve $B(L)$ to the abscissa $L = L_b$ (with exceptions which are given later).

Annex C, item a), gives the table of the relations $r = [CV\ (8\ mm, L_w)]/[CV\ (8\ mm, 250\ m)]$ for all possible running speeds and for different values of slope $(-n)$ of curve $B(L)$: it enables the expected under-estimation to be evaluated in each case.

It is found that the method described will give under-estimations over 5 % only in the cases of some abnormal yarns and slivers having wide long-term variations (n between 0,1 and 0,3).

The following procedure shall therefore be adopted :

1) if the determination of short-term irregularity only is required, and if it is performed according to the above method, only the value of $CV\ (L_b, L_w)$ is mentioned in the test report;

2) if the determination of short-term irregularity forms part of a summary of the $B(L)$ curve and if r is lower than 0,96 a more exact estimation of $CV\ (L_b, 250\ m) \approx CV\ (L_b, L_p)$ is obtained by multiplying the result $CV\ (L_b, L_w)$ of the test by $1/r$; r must be taken from the table in annex C a);

3) if only the short term cross-sectional irregularity is required, but if it is impossible (for example because of insufficient length of sample) to conform to the method described and in particular if it is impossible to use the prescribed values of running speeds and test times, the instructions given in annex D are to be followed.

Total length L_t. As samples must normally be taken from several production units (i.e. several packages or cans), according to the instructions in clause 6, L_t will indicate the total length of yarn used for a regularity test on the total of production units examined (L_s being the length drawn from one production unit only).

3 PRINCIPLE

The measurement of short-term cross-sectional irregularity is performed using an electronic device employing a capacitive measuring head.

The textile material, passing between the electrodes of a condenser, causes a variation in its capacity, proportional to the mass of material present between the electrodes.

An electronic transducer then provides a variation in signal corresponding to this variation in capacity.

Thus the instrument measures continuously a function $f(t)$, representing the mass of the L_c mm of yarn or sliver present at time t, between the plates of the measuring condenser. ($L_c = 8$ mm for yarns, slots 5 to 8; 12 mm for roving, slots 2, 3, 4; 20 mm for slivers, slot 1.)

This electric signal $f(t)$ is recorded on graph paper and transferred to a simplified analogue computer, called an "integrator". This evaluates the variation between the masses of the L_c mm of yarn or sliver within a fairly long length L_w, by calculating a coefficient of variation $CV\ (L_b, L_w)$, which constitutes a value close to $CV\ (L_b, L_p)$ defined above. (It will be recalled that $L_b \approx L_c$.) Some types of integrator evaluate a coefficient of deviation $CD\ (L_b, L_w)$.

NOTE — Up to the present the coefficient of variation $CV\ (L_b, L_w)$ is indicated in evenness tester instruction manuals as C.V. and the coefficient of deviation $CD\ (L_b, L_w)$ as U, these two values being generally expressed as a percentage of the mean of the mass per unit length of yarn.

4 APPARATUS

An **electronic evenness tester**[2] with the following characteristics :

1) **The main instrument**

having on the front the measuring condensers for various types of material grouped into one unit, together with the various control knobs and a milliammeter with

1) L_s = length of sample.

2) A more fully automated tester may be used, in which case the apparatus description and test procedure will need slight modification.

central zero graduated from − 100 % to + 100 % and showing the function $f(t)$. The main instrument is fitted with several accessories allowing various types of material to be unwound and suitable for all types of package carriers.

2) **The integrator**

This exists in two types, semi-automatic and automatic.

a) *The semi-automatic model*

This model has control knobs and a dial with two separate scales : an upper scale "integration" indicating a coefficient of deviation *CD* % marked *U* % on the apparatus, and a small lower scale marked "Average Value" which registers a running mean of mass per unit length of the textile material.

b) *The automatic model*

This model has control knobs, "Evaluating time" knob indicating the time of integration, and a dial recording only *U* % or *CV* %.

3) **The recorder**

This enables the function $f(t)$, given by the main instrument, to be recorded on graph paper.

A suitable machine is described in annex B.

5 ATMOSPHERE FOR CONDITIONING AND TESTING

5.1 Conditioning

The sample of yarn or roving to be tested should not be removed from its package (ball, can, etc.) before conditioning or before testing.

The balls or cans are to be exposed to the atmosphere of the testing location for at least 24 h if only one test is to be made on each ball (i.e. if only 250 to 400 m on the outside of the ball are to be unwound).

In the case of yarn packages only, if more than one test is to be carried out (more than 250 to 400 m unwound) it is necessary to extend conditioning to 48 h.

5.2 Testing atmosphere

5.2.1 *Control laboratories*

Preferably the test is to be performed in the standard atmosphere for testing defined in ISO 139, observing the following points :

1) the machine must be sufficiently far away from the air and moisture inlets (at least 1,5 m); this also applies to heat sources;

2) the humidification control device is to be set to obtain a sufficiently narrow "dead zone", so that the range of relative humidity during the humidification and rest cycles does not exceed 4 % (otherwise too steep a rise in relative humidity often occurs during the humidification cycle with possible drift on the evenness tester).

5.2.2 *Mill laboratories*

The standard atmosphere corresponding to the above requirements is preferred but is not essential. It suffices for conditioning and testing to be carried out in a sufficiently stable atmosphere both in temperature and humidity conforming to the following conditions :

1) mean temperature to be between 18 and 28 °C; variations around this mean not to exceed ± 3 °C during the total duration of conditioning and testing, and the temperature change not at any time to exceed 0,05 °C/min;

2) mean relative humidity between 50 and 75 %, but the variations around this mean not to exceed ± 3 % relative humidity during the total duration of conditioning and testing, and the change in relative humidity never to exceed 0,25 %/min.

At the time of test, the apparatus, (evenness tester and integrator) must have been in the atmosphere of the testing location (standard atmosphere or stable atmosphere as defined above) for at least 5 h.

6 SELECTION OF TEST SPECIMENS

As variations between production units are relatively important it is absolutely necessary to repeat the test described in clause 8 on a number of production units, taken at random from the lot or between machine heads, in order to obtain a value of *CV* (L_b, L_w) characterizing a lot or any given production with sufficient accuracy.

The following list indicates the minimum specimen required for each type of material :

— top sliver, sliver and roving from 1st, 2nd and 3rd drawing passages : 3 balls or 3 cans;

— finisher roving : 4 balls;

— yarn : 10 packages.

To check whether sampling is sufficient, calculate the coefficient of variation between production units of the *CV* (L_b, L_w) values found. Allow an interval of confidence of ± 4 % at 90 % probability for the grand mean.

If the confidence interval found is greater, increase sampling until the accuracy required for the mean is reached.

7 PREPARATION OF SAMPLES FOR TEST

After the conditioning period indicated in 5.1 the packages of yarn or finisher roving are placed directly on the evenness tester, using the appropriate unwinding accesories.

The cans of roving or sliver should also be unwound in the normal way, using the concave channel below the measuring condenser.

For balls of top sliver, a special accessory is used, consisting of a vertical or horizontal spindle mounted on ball-bearings, on which the ball is mounted; the sliver is then taken through the concave channel as above. If this accessory is not available, the ball of top sliver is to be wound very carefully into a can before testing.

8 TEST PROCEDURE

The procedure differs according to whether it is for sliver, roving or yarn and type of integrator; however, a large part of the preliminary operations are identical for all cases. This part common to all will be described first.

8.1 Control of correct functioning

The preliminary condition for any test is to make sure that the main instrument and the integrator are functioning correctly.

For this purpose the evenness tester must undergo daily and monthly checks as described in annex B.

In case of doubt it suffices to carry out complete check 1, which guarantees the correct functioning of the instrument except in the rather rare case of intermittent breakdowns. When very great accuracy is required (in the case of an inter-laboratory trial, litigation, etc.) it is recommended that check 1 be carried out immediately before testing.

8.2 Starting up

The evenness tester in the "Normal Test" position on the range ± 100 % is switched on by turning the "Main Supply" knob to position I. At the same time the automatic integrator is switched on. ("Recorder" knob of main apparatus must be at I.)

Knob 2 "Average Value" is then set at an average position; for instruments B10 to B18 the "Average Value" potentiometer is set at position 5 : for instruments B19 and later models, the "Average Value" switch is set at position 16, the potentiometer at position 0. By means of knob 1 "Adjustment without material", the milliammeter needle of the main instrument is brought near to − 100 %.

The integrator is connected to the evenness tester "Recorder" knob of the main instrument at I), but left in the rest position, lever at "Clear" on the semi-automatic integrator. The machine is then left in this state for at least half an hour before starting tests. (The starting-up procedure must be repeated each time the machine has been out of action for more than 5 min.)

8.3 Adjusting the minimum position without material to − 100 %

Before each test, check very carefully if the measuring slots are clean. If necessary clean them with a piece of photographic film.

For adjustment, the integrator is connected to the evenness tester but left in the rest position : lever at "Clear" on the semi-automatic integrator. The evenness tester at the start of the test is at the "Normal Test" position. Move knob 1 "Adjustment" without material until the milliammeter reading of the main instrument is near the mark − 100 %. Move the "Service Selector of the evenness tester" knob 4 into the "Adjustment" position. Then, still without material in the measuring slots, proceed as follows.

a) Find the minimum reading on the milliammeter of the main instrument by moving knob 1 "Adjustment without material". The minimum is surrounded by a small dead zone in which the rotation of knob 1 does not affect the position of the needle. By small repeated movements of knob 1 passing from one part to another of the minimum, get as near as possible to the centre of this dead zone.

b) Now pass to position "Normal Test" (knob 4) and check that the minimum thus obtained coincides with the mark corresponding to the reading − 100 %. If the deviation is greater than ± 1 %, get the correct reading by means of the "− 100 %" adjustment (knob 106 under the flap on the right of the machine).

This adjustment is essential and must be carried out in two stages, a) and b), strictly in the manner described, before each test.

8.4 Selection of scale and slot. Unwinding of material

8.4.1 *Selection of scale*

With knob 4 in the "Normal Test" position, select the scale with knob 3 according to the following :

Yarn : ± 100 %

Roving : ± 50 %, occasionally 25 %

Sliver : ± 25 %, occasionally 12,5 %

For slivers and roving, in doubtful cases, select the scale for which the *U* % or *CV* % reading on the integrator is in the right-hand half of the graduated scale of the dial, checking, however, that readings do not go off the scale.

8.4.2 *Selection of slot*

The correct selection of slot is of the greatest importance for the conformity of the result to the reference measurement (see annex E).

For this selection it is necessary to know within ± 2,5 % the count of the material to be tested.

In annex E, the table gives the slot to be selected for a given count. The slot selected must always be indicated in the test report.

8.4.3 *Unwinding of the material*

When the material has been introduced into the selected slot, the drive is then switched on, at 50 m/min for yarn or at 25 m/min for sliver and roving.

The following general precautions are to be observed :

a) running must be continuous and uniform without jerks;

b) tension in the material must be uniform; it must not be high enough to cause drafting;

c) intermittent slipping in the carrier rollers must be avoided;

d) the material must be guided correctly so as to pass within the measuring condenser without excessive transverse displacement in the condenser.

For delicate slivers it is sufficient to give a few turns of twist along the length between the ball and the carrier rollers, and to regulate the slight friction applied to the axis of the bobbin so that starting up occurs without any break, and running proceeds without excessive variation in tension.

8.5 Centring the mean of the reading to zero on the dial of the evenness tester

After checking that the passage of material through the instrument conforms to the above conditions, the mean of the mass is centred on the central 0 in the following way :

Using the "Average Value" knob (or knobs) 2 make the dial scale needle of the evenness tester oscillate around the central value 0 %. To complete this setting, move temporarily to position "Inert Test" using knob 4 and continue to improve the centring "Average Value" for between 15 s and 1 min according to the size of the long-term irregularities in the material. Then switch to the "Normal Test" position (knob 4) and start operating the integrator.

Once the correct centring on 0 is obtained, leave knob 2 "Average Value" in its last position. From this moment and for the whole duration of the test (i.e. 10 readings = 5 min on the semi-automatic integrator or 1 reading = 5 min on the automatic integrator) on no account must the settings of the main instrument be adjusted.

8.6 Measurements on the integrator

8.6.1 *Semi-automatic integrator*

From the moment when the "Average Value" settings of the main instrument are left in their final position, wait for 30 s (or a little longer) with the lever of the integrator at the "Clear" position. After 30 s (2 intervals between luminous impulses of the red lamp of the integrator) place the lever in the "Low" position, and leave it there for the duration of the test.

Wait another minute (4 luminous impulses) before taking the first reading on the integrator.

To carry out a reading : Change to the "Integration" position; take the reading on the upper scale of the integrator dial corresponding to the scale selected by knob 3 at the exact moment when the luminous impulse of the red lamp ceases; change immediately to the "Average Value" position and note with its sign the correction indicated on the small lower scale (to ± 0,5 of the nearest division). Again change to the "Integration" position and prepare to read the next value.

8.6.2 *Automatic integrator*

On this type of integrator the result is obtained in one reading at the end of the "evaluation time". The information on the variation in irregularity and mean cross-section during the test given by semi-automatic integrators by the series of "Integration" and "Average Value" readings is thus lost in this case; it must be replaced by a recording of the instantaneous local mass (function $f(t)$) during the test.

The operations are thus as follows :

Switch on the instrument by knob 7 "Main Supply" at the same time as the main instrument.

Set knob 9 "Range of Scale" of the integrator to the same reading as knob 3 of the main instrument.

At the moment when the "Average Value" settings of the main instrument are left in their final position, switch on the recording device, then set knob 5 "Evaluating time" at the zero stop by turning it anti-clockwise (the paper speed of the recorder should be 10 cm/min).

After an "evaluation time" given later for each type of material, read the results (only one reading) on the dial on the scale corresponding to that chosen by knob 9 of the integrator.

8.7 Particular instructions for each type of integrator

8.7.1 *Semi-automatic integrator*

With integrator knob at the "Low" position, take readings on the integrator every 30 s (every 2 impulses) at the exact moment when the luminous impulse ends : total of 10 successive readings corresponding to 250 m of yarn in 5 min. Just before the first test, switch on the recorder using the "Recorder" knob of the integrator (paper speed : 10 cm/min).

8.7.2 *Automatic integrator*

Read the result after an evaluation time of 5 min (knob 5 of timing device at 5). As soon as the timing device is in operation (at 0) engage the recorder while turning knob 8 of the integrator to "Output".

8.8 Final operations

After completing the readings of the integrator, stop the flow of material, remove it from the slot and check that the milliammeter pointer is indicating about − 100 %. (A reading between − 100 % and − 98 % is admissible for a normal test.)

If this is not the case, repeat the tests after checking the cleanliness of the slots.

For the semi-automatic integrator the switch should be set at 0 at the end of a test and the recorder stopped by the "Recorder" knob of the integrator. For the automatic integrator, knob 5 "Evaluating time" goes to the base of the track; the recorder is stopped by means of button 8 of the integrator. Detach the recording paper for fixing to the test report. For the next test reset to "Adjustment" (button 4) and resume the operations described in 8.3 to 8.8.

9 CALCULATION AND EXPRESSION OF RESULTS

General instructions for all material

9.1 Semi-automatic integrators

Each pair of readings "Integration" and "Average Value" is written down on the same line; the successive "Integration" readings form the first column and the "Average Values" a second column.

At the end of the test the following calculations are carried out :

1) Arithmetic mean of the "Integration" readings, indicated as provisional U % (linear integrator type L).

2) Algebraic mean of the "Average Value" readings indicated as m.

3) Calculations of CD % by the formulae :

$$CD\,\% = \frac{\text{Provisional } U\,\%}{100 + 4\,m} \times 100 \text{ (100 \% range)}$$

$$CD\,\% = \frac{\text{Provisional } U\,\%}{100 + 2\,m} \times 100 \text{ (50 \% range)}$$

$$CD\,\% = \frac{\text{Provisional } U\,\%}{100 + m} \times 100 \text{ (25 \% range)}$$

$$CD\,\% = \frac{\text{Provisional } U\,\%}{100 + 0{,}5\,m} \times 100 \text{ (12,5 \% range)}$$

(m is expressed in scale divisions with the sign of the algebraic sum).

Or use correction tables 126.851 issued by Zellweger.

4) Record the value of CD % (formerly designated U %) then evaluate CV % by the formula $CV\,\% = 1{,}25\,CD\,\%$.

The coefficient of variation obtained in this way is to be indicated by

$$CV\,(L_b, L_w)$$

by replacing L_b and L_w respectively by the particular values of slot length in millimetres, equivalent length in metres; it is to be expressed as a percentage.

Example : CV (8 mm, 55 m) = 18 % (for L_w; see annex C, b)).

9.2 Automatic integrator

At the end of the test (after 5 min), take the dial reading of U % or CV % as the case may be. For type L integrators evaluate CV % by the formula : $CV\,\% = 1{,}25\,U\,\%$.

The coefficient of variation obtained in this way is then to be indicated as $CV\,(L_b, L_w)$.

10 TEST REPORT

Indicate in the test report, besides the results obtained, reference to this International Standard, the scale and slot selected, the measurement graph (50 cm) and all possible incidents not specified in this International Standard that may have influenced the results.

ANNEX A

BIBLIOGRAPHY

NOTE — This bibliography only includes references specially relevant to the Zellweger-Uster instrument utilised directly for the standard method of test. Works of a more general nature or concerning other evenness testers will be found in the bibliographies of some of the cited references.

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ANNEX B

ZELLWEGER-USTER EVENNESS TESTER[1]

The principal features of this machine are given in clause 4 and shown in the figure.

B.1 PERIODIC CHECKS OF THE EVENNESS TESTER AND INTEGRATOR

B.1.1 Introduction

The Zellweger-Uster evenness tester has three important adjustments which greatly affect the accuracy and reproducibility of the results. These are :

1) the adjustment of the minimum position without material at − 100 %;

2) the amplification adjustment;

3) the range adjustment.

These adjustments are carried out by three potentiometers on the right of the machine under a flap and indicated respectively as : "− 100 %" (knob 106), "Amplification" (knob 137) and "Adjustment of ranges" (knob 126).

When the machine leaves the factory it passes through a control and calibration laboratory where an exact adjustment of the three potentiometers is carried out according to certain standards; the adjustment position is indicated by a yellow spot on the graduated scale in front of each potentiometer.

However, during normal use of the machine, ageing of the valves causes a progressive change in these three adjustments, which must be compensated by changing the position of the three potentiometers in question.

It is very important to maintain the machine in the original condition to ensure reproducibility of the results within the period.

The "− 100 %" adjustment is of great importance : it sets the reference point from which the variations of mass of sliver, roving or yarn are measured, and thus directly influences the accuracy of the test. The maintenance of the "Amplification" adjustment at its original value allows measurement of yarns of a specific count to be always made in the same measuring slot under the same conditions. It is known that *U* % readings for the same yarn obtained in two adjacent slots differ by about 7 % (relative) on average. Now, if amplification is allowed to reduce progressively by valve ageing without re-establishing it by potentiometer 137, at some time it will be necessary to change the measuring slot for some counts of yarn.

Finally, the range of adjustment serves for centring the extent of measurement, for ranges of 12,5 %, 25 % and 50 % on the same central linear portion of the amplifier, around 0 %, as that used for the 100 % range, and for preserving the calibration of the integrator on all the scales.

This precaution enables optimum linearity to be obtained on all the scales, and thus differences in *U* % reading to be avoided, for an identical sliver measured on two different scales.

On recent instruments, these different adjustments may be easily carried out by the user;, a series of checks at fixed intervals enables them to be controlled and rectified at the right time.

The "− 100 %" adjustment, which is of great importance, is the subject of a check to be carried out before each test "Adjusting the minimum position without material at − 100 %" (see 8.3).

The other two adjustments are checked during the complete monthly check.

Besides this monthly check, a more simple daily check is necessary to ensure the correct functioning of the machine at all times.

The checks described only apply to recent machines — types GGP.B10 and later models.

B.1.2 Complete monthly check

Except in the fairly rare case of an intermittent breakdown, this check enables the correct functioning of the machine to be completely verified. It should be carried out each month for normal use of the instrument; it is also to be repeated before carrying out tests requiring exceptional accuracy, as in interlaboratory tests, for example.

B.1.2.1 *Check of mechanical zeros*

This check is normally to be carried out every month, but repeated every time the machine is moved. With the evenness tester switched off (knob "Main supply" at zero) for at least 5 min, check that pointers of milliammeters of the main instrument and semi-automatic integrator coincide with the arrow mark on the extreme left.

For automatic integrators it is not necessary to adjust the mechanical zero with the apparatus switched off, but should be done with it switched on, according to the instructions of Zellweger manual 136.270.

1) The information given on this machine is not intended to favour its use or to give preference to this apparatus. Other apparatus giving equivalent results may be used.

These checks must be made with care, avoiding parallax effect and any sticking due to possible friction of the moving parts of the pivots of the milliammeter. To do this, place oneself facing the centre of the apparatus preferably with one eye closed, the other being exactly opposite the reference mark. Tap the dial lightly with the fingers before observing the coincidence.

If the pointer observed in this way does not exactly cover the reference mark, move it on to this mark by turning, with a small screwdriver, the screw on the front of the milliammeter casing, in the centre, below the dial.

B.1.2.2 *Check of amplification of the main instrument*

As soon as the coincidence of the pointers with the reference marks has been checked and if necessary re-established, set up the machine.

B.1.2.2.1 PROCEDURE FOR SETTING UP THE APPARATUS

This setting up procedure should be carried out every morning and after every period out of use longer than 5 min.

With the evenness tester in the "Normal Test" position, on scale ± 100 %, set knob 2 "Average Value" potentiometer at position 5; on B19 machines and later models set the "Average Value" switch at position 16.

Then switch on the evenness tester (the integrator also, if it is of the automatic type) by moving the "Main Supply" knob to position 1.

By means of knob 1 "Adjustment without material", move the pointer of the milliammeter of the main instrument to give a reading about the central zero of the scale.

The integrator is connected to the evenness tester ("Recorder" knob of the main instrument at I), but left in the rest position : lever at "Clear" on the semi-automatic integrator, counter at zero on the automatic integrator.

The machine is then left in this state for at least half an hour before normal tests, and preferably 1 h before a daily check on a calibration film or a complete monthly check. To save time, these two checks may be carried out to advantage after a further hour of normal usage, i.e. between two tests on yarn or sliver (do not forget, however, the preliminary check of mechanical zeros with the machine switched off).

B.1.2.2.2 PRELIMINARY ADJUSTMENTS ON THE MACHINE

After completing the setting up procedure or after a further period taken up by normal tests, perform a very careful adjustment of the minimum position without material by means of knob 1 "Adjustment without material", as indicated in 8.3. Check particularly, and if necessary adjust with great care, the coincidence of the pointer at the minimum position with the red mark − 100 %, in "Normal Test" position, scale 100 %.

B.1.2.2.3 RUNNING THROUGH THE CALIBRATION FILM

The calibration film is then introduced into slot No. 4 of the measuring condenser, following exactly the course shown on the leaflet in the calibration film box. With the machine set at "Normal Test" on the range ± 100 %, switch it on to run at 8 m/min. Watch particularly the following points :

— the play of the film between the rod or the metal rim and the guide discs is to be of the order of 1 to 2 mm, so that there is no appreciable lateral displacement nor intermittent jamming by the rubber disc;

— the development of static charges on the film must be avoided (the film must not be drawn against the machine at any point); for this purpose, the atmosphere must be sufficiently humid (at least 55 % relative humidity); antistatic rubber carrier rollers are to be used if necessary;

— movement must be in the direction of the arrow marked on the film, this being placed on the inside;

— in general, the movement of the film must be regular, smooth and without marked jerks;

— the film must be in perfect condition, flexible, not dried up, without obvious scratches, breaks or bends (keep it protected from heat and the sun).

If all these points are in order, move the "Average Value" adjustment No. 2 so as to obtain very good centring of the milliammeter pointer oscillations around zero on the scale. (Machines B19 and later models : first move the lower knob of the switch, then the upper knob of the potentiometer.) To complete this adjustment on central zero, pass to the "Inert Test" position, then after about 15 s again move the "Average Value" knob (potentiometer only) to obtain perfect centring.

B.1.2.2.4 EVENTUAL CORRECTION OF AMPLIFICATION

When the small remaining oscillations are perfectly symmetrical around 0, carry out the following operations, maintaining the "Inert Test" position :

— on an evenness tester of B10 to B18 type : knob 2 "Average Value" controls a potentiometer graduated from 1 to 10. Note the reading of the knob index interpolating to one-tenth of a scale division.

The deviation between the value thus obtained and the nominal value of "Average Value" (B10 to B18) marked in the film box must not exceed ± 0,5 division.

— on an evenness tester of B19 type and later models : knob 2 controls a potentiometer with 32 positions. It is completed by a fine adjustment situated just above, and constituting a potentiometer graduated from 0,1 to 1.

Note the positions of these two knobs and add together.

The deviation between the value thus obtained and nominal value of "Average Value" marked in the film box, must not exceed ± 0,5. (Example : position of lower knob : 19; upper knob : 0,3 : as the deviation between the total 19,3 and the nominal value 17,0 marked is greater than 0,5, a correction must be carried out.)

In the case of too high deviation, amplification must be re-established at its normal value. To do this, while the film continues to pass through, on "Inert Test" adjust the knob or knobs of adjustment 2 "Average Value" to the nominal position marked in the film box. The pointer of the dial of the main instrument will then diverge from the central 0. Exact centring to 0 is obtained by moving very slowly knob 137 "Amplification" adjustment found on the right of the evenness tester under the flap. Then wait about 30 s without turning the knob before ensuring definite coincidence.

B.1.3 Adjustment of the ranges

Stop the carrier motor and take out the calibration film. Again carry out very carefully the adjustment of minimum position without material to − 100 %. At the end of this adjustment with the machine in the "Normal Test" position and on the ± 100 % range, set the "Average Value" potentiometer at graduation 5 (in the case of models B10 to B18) or the switch at position 16 and the potentiometer at position 0 (in the case of models B19 and later).

Turn knob 1 "Adjustment without material" slowly clockwise until the milliammeter pointer of the main instrument coincides exactly with the central 0 % graduation.

At this moment, pass to the ± 50 % scale; note the deviation in % of the milliammeter pointer read on the ± 100 % scale; then pass successively to the ± 25 % range, then ± 12,5 %.

On no range should the deviation exceed ± 10 % read on the ± 100 % scale on the dial.

Otherwise, with the switch still on the ± 12,5 % scale, move knob 126 "Adjustment of Ranges" found on the right of the machine to obtain coincidence of the needle with central 0 of the dial on the main instrument.

At this moment check the accuracy of the new adjustment, starting again on the ± 100 % scale and proceeding to the ± 12,5 % scale.

B.1.4 Additional check

In the "Adjustment" position while finding the minimum position without material, observe the width of the dead zone around this minimum where the rotation of knob 1 has no effect on the needle position. This rotation must not exceed 10° (about 3 times greater than the width of the white spot on the knob).

B.1.5 Check of the accuracy of the reading obtained on the integrator by means of the calibration film

B.1.5.1 *Preliminary adjustments*

First of all, carry out a very careful adjustment of the minimum position without material at − 100 % by means of knob 1 (see 8.3).

Then with the machine on the "Normal Test" position, on range 100 %, follow the instructions given in B.1.2.2.3 of annex B for the insertion of the calibration film. Then, after correcting the centring in the "Inert Test" position, return to the "Normal Test" position before carrying out tests.

B.1.5.2 *Tests on the integrator*

Carry out the reading of the coefficient of variation (*CV* %) or the coefficient of deviation (*CD* %) (actually marked *U* %) on the integrator for the normal test.

On the semi-automatic integrator, the mean of five readings taken at intervals of 30 s is taken, using the corrections of table 126.851.

On the automatic integrator, take a reading after waiting for 2 min.

At the end of the test, switch off the drive, remove the calibration film from the slot and check that the reading without material in the "Normal Test" position has stayed at − 100 % (permissible deviation : 1 % maximum). Otherwise recommence the complete check.

B.1.5.3 *Evaluation of the test result*

The nominal *CV* % or *U* % value is indicated in the calibration film box for each type of integrator. (Check the type on the plate fitted to the integrator.)

- If the difference between the value obtained and the nominal value is lower than or equal to ± 0,5 % (absolute), the machine is regarded as being in good working order. No correction must therefore be made to normal readings of *CV* % or *U* %, as a function of a deviation from nominal value comprised between the above limits.

- If the difference is greater than ± 0,5 % the machine is no longer in good working order. In the case of an automatic integrator, carry out a check of the integrator (chapter 7 of Zellweger manual 136.270).

The semi-automatic integrator has no adjustment accessible to the user.

B.1.6 Attention by a service engineer

If one of the adjustments mentioned in the above is impossible, that is to say :

1) the knobs 106 or 126, or 137 are at the bottom of their travel on the main instrument;

2) the "Adjustment" dead zone is too wide;

3) one or more of the adjustment potentiometers of the automatic integrator are at the bottom of their travel;

4) the semi-automatic integrator (not adjustable) is giving a deviation of more than 0,5 % on calibration film;

an Uster service engineer must be asked to call.

B.2 DAILY CHECK CALIBRATION FILM

This check is to be carried out, for example, every morning after a starting up period for the evenness tester of at least half an hour, or preferably after a further hour of normal usage, between two tests on yarn or sliver.

For this check follow the instructions given above in B.1.5.

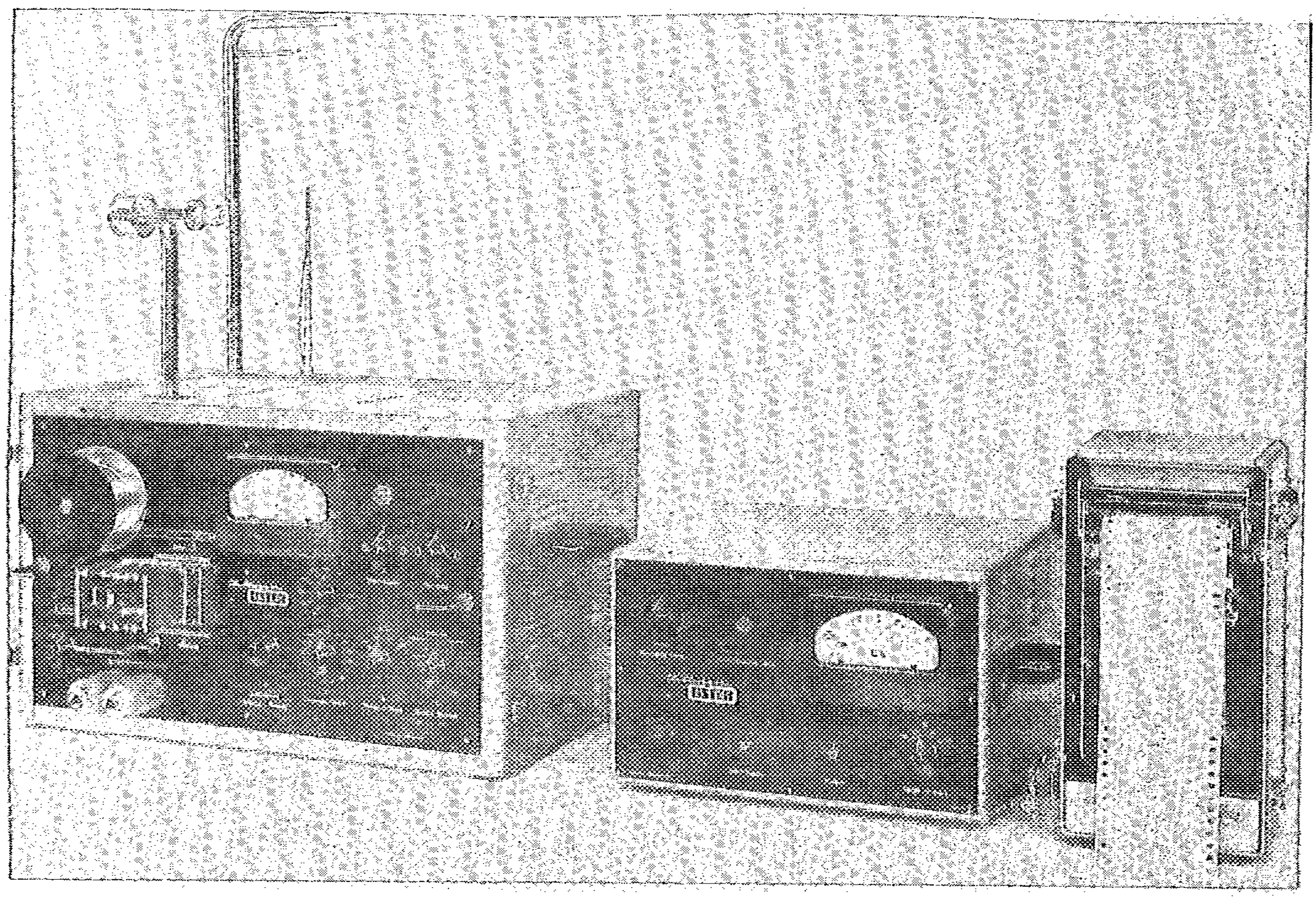

FIGURE — **The Zellweger-Uster evenness tester**

ANNEX C

a) Table of values of the relation

$$r = \frac{CV\ (8\ \text{mm},\ L_w)}{CV\ (8\ \text{mm},\ 250\ \text{m})}$$

n	V m/min						
	Sliver				Yarn		
	2	4	8	25	50	100	200
0,1	0,75	0,80	0,85	0,91	0,94	0,97	1,00
0,2	0,81	0,86	0,89	0,94	0,96	0,98	1,00
0,3	0,86	0,90	0,93	0,96	0,98	0,99	1,00
0,4	0,90	0,93	0,95	0,98	0,99	0,99	1,00
0,5	0,93	0,95	0,97	0,99	0,99	1,00	1,00
0,6	0,95	0,97	0,98	0,99	1,00	1,00	1,00
0,7	0,96	0,98	0,99	1,00	1,00	1,00	1,00
0,8	0,98	0,99	1,00	1,00	1,00	1,00	1,00

b) Table of values of L_w

1) For determination of short term levelness only, take for convenience the value of L_w for $n = 0{,}6$ in the case of yarns and finisher rovings and $n = 0{,}4$ for slivers.

2) For determination of short term levelness as part of the establishment of a $B(L)$ curve utilise the value found for n.

L_w in metres

n	V m/min						
	Sliver				Yarn		
	2	4	8	25	50	100	200
0,1	2,47	4,94	9,88	30,9	61,8	123,5	247
0,2	2,42	4,84	9,68	30,3	60,5	121,0	242
0,3	2,37	4,74	9,48	29,7	59,3	118,5	237
0,4	2,32	4,64	9,28	29,0	58,0	116,0	232
0,5	2,27	4,54	9,08	28,4	56,8	113,5	227
0,6	2,21	4,42	8,84	27,6	55,3	110,5	221
0,7	2,16	4,32	8,64	27,0	54,0	108,0	216
0,8	2,11	4,22	8,44	26,4	52,8	105,5	211
0,9	2,06	4,12	8,24	25,8	51,5	103,0	206

ANNEX D

INSTRUCTIONS FOR TEST ON A SMALL SAMPLE

In the case where only a very small amount is available from each package, making it impossible to follow the test method described (i.e. a yarn specimen shorter than about 300 m or a sliver specimen shorter than about 150 m), account must be taken of the fact that the automatic integrator (because of particular properties of the circuit used) gives results affected by a systematic error when the integration time is too short; the sample applies when the number of readings on the semi-automatic integrator is insufficient.

The minimum integration time on the automatic integrator is 2 min; on the semi-automatic integrator five readings (2,2 min) constitute a minimum.

In the case of too short a specimen, therefore, running speeds of 25 m/min (slivers and rovings) and 50 m/min (yarn) are to be preferred for samples of the order of 180 m of yarn or 90 m of sliver, thus permitting, after preliminary adjustment, the integration times mentioned above.

For still shorter specimens, choose the highest possible running speeds compatible with the minimum integration times.

These particular test conditions are to be indicated in the test report.

ANNEX E

SELECTION OF MEASURING SLOT FOR WOOL SLIVERS AND YARNS IN THE STANDARD ATMOSPHERE

Slot	Slivers Minimum linear density (tex)	Yarns Maximum linear density (tex)
1	12 600	40 000
2	3 450	12 500
3	1 120	3 330
4	161	1 110
5	71	159
6	22	67
7	8,06	21
8	4 to 5	8
Slot	Maximum metric count	Minimum metric count
1	0,079	0,025 approx.
2	0,29	0,080
3	0,89	0,30
4	6,2	0,90
5	14	6,3
6	46	15
7	124	47
8	250 to 200 approx.	125

ANNEX F

In 1966 an interlaboratory trial was carried out between 10 laboratories in 8 countries, members of the I.W.T.O., to determine confidence intervals for short term worsted yarn levelness on the Zellweger tester. The results of this trial are summarised below.

F.1 95 % confidence intervals of *U* % for tests in one laboratory (on the same apparatus) expressed in the same units as *U* % for a mean obtained on a sample of *n* bobbins with *q* tests per bobbin.

(1 test = average of 10 readings during 5 min for semi-automatic integrator; 250 m of yarn or one reading on an equivalent length for an automatic integrator. See table 1.)

TABLE 1

n	*q* = 1	*q* = 2	*q* = 3	*q* = 5
1	1,45	1,29	1,23	1,18
2	1,02	0,91	0,87	0,84
5	0,65	0,58	0,55	0,53
10	0,46	0,41	0,39	0,37
15	0,37	0,33	0,32	0,31
20	0,32	0,29	0,28	0,26
30	0,26	0,24	0,22	0,22
50	0,20	0,18	0,17	0,17

F.2 Possible differences (95 % level of significance) between results of *U* % for tests in the same laboratory (on the same apparatus) expressed in the same units as *U* % for means of a sample of *n* bobbins, *q* tests per bobbin, taken at random from the same lot of yarn.

(1 test = mean of 10 readings for semi-automatic integrator, for a total time of 5 min corresponding to 250 m of yarn — see table 2.)

TABLE 2

n	*q* = 1	*q* = 2	*q* = 3	*q* = 5
1	2,05	1,82	1,74	1,67
2	1,45	1,29	1,23	1,18
5	0,92	0,82	0,78	0,75
10	0,65	0,58	0,55	0,53
15	0,53	0,47	0,45	0,43
20	0,46	0,41	0,39	0,37
30	0,37	0,33	0,32	0,30
50	0,29	0,26	0,24	0,24

F.3 95 % confidence intervals of *U* % for tests in two laboratories (on two different apparatus) expressed in units of *U* % for a mean obtained on a sample of *n* bobbins with *q* tests per bobbin.

(1 test = average of 10 readings during 5 min for semi-automatic integrator on 250 m of yarn or one reading on an equivalent length for an automatic integrator. See table 3.)

TABLE 3

n	*q* = 1	*q* = 2	*q* = 3	*q* = 5
1	1,72	1,59	1,55	1,51
2	1,39	1,31	1,28	1,25
5	1,14	1,10	1,08	1,07
10	1,04	1,02	1,01	1,01
15	1,01	0,99	0,99	0,98
20	0,99	0,98	0,97	0,97
30	0,97	0,96	0,96	0,96
50	0,96	0,95	0,95	0,95

F.4 Possible differences (95 % level of significance) between results of *U* % for tests in two laboratories on different apparatus, expressed in units of *U* % for means of a sample of *n* bobbins, *q* tests per bobbin.

(1 test = 10 readings for the semi-automatic integrator for a total time of 5 min corresponding to 250 m of yarn. See table 4.)

TABLE 4

n	*q* = 1	*q* = 2	*q* = 3	*q* = 5
1	2,44	2,25	2,19	2,13
2	1,96	1,85	1,81	1,77
5	1,61	1,55	1,53	1,52
10	1,47	1,44	1,43	1,42
15	1,42	1,40	1,40	1,39
20	1,40	1,38	1,38	1,37
30	1,37	1,36	1,36	1,36
50	1,35	1,35	1,34	1,34

NOTE — Details of the enquiry and the statistical analysis for the above values will be found in reference 6 of annex A.